



Invent2

Exhibit 1

25833

2015

WJB

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\* TI INVENTION INNOVATION DISCLOSURE \*  
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SEND COMPLETED FORM TO: TI CORPORATE PATENTS

ATTN: AGATHA GUTIERREZ PC DROP PCN1  
(MSGID "AGKG" FAX: 995-3170; M/S 219)

IF YOU ARE EMPLOYED BY A TI SUBSIDIARY COMPANY, SEND THIS FORM TO YOUR SITE COORDINATOR.

HELPLINE: GARY HONEYCUTT IN PATENT ACTIVITY 995-1363 (MSGID "GCH2"; FAX: 995-3170)

PRINTED DISCLOSURE FORMS:  
OBTAIN FROM YOUR DEPARTMENTAL SECRETARY  
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YOU CAN ALSO OBTAIN A SOFT-COPY VERSION OF THIS FORM USING THE TIOLR SYSTEM.

TO VIEW THE FORM TYPE THE FOLLOWING COMMAND IN IMS:

T INVENT.FORM

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IF YOU DON'T KNOW HOW TO USE TIOLR, PLEASE DISCUSS YOUR SYSTEM ADMINISTRATOR. BESIDES BEING ABLE TO GET THE DISCLOSURE FORM, THERE IS A WEALTH OF OTHER INFORMATION ON TIOLR.

TO PREPARE YOUR INVENTION DISCLOSURE, FOLLOW THE STEP-BY-STEP DIRECTIONS ON THE FORM THAT FOLLOWS. TYPE OR PRINT ANSWERS TO THE QUESTIONS IN THE SPACES PROVIDED.

\*\*\*PLEASE PROVIDE ANSWERS TO ALL OF THE QUESTIONS\*\*\*

IF YOU ALREADY HAVE AN ENGINEERING SPEC, PLEASE SEND IT WITH YOUR INVENTION DISCLOSURE. COMPUTER DOCUMENTATION AND DRAWINGS, MARKETING FOILS, NOTEBOOK ENTRIES, PAPER MANUSCRIPTS, ARTICLES, AND ANY OTHER MATERIAL THAT YOU ALREADY HAVE CAN BE COPIED OR SENT ELECTRONICALLY.

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MEC has  
copy of  
disclosure

1. Please suggest a descriptive title for your invention:

"Optimized Circuit Design Layout for High Performance Ball Grid Array Packages."

2. What is the problem solved by your invention?

"A BGA substrate circuit layout suitable for use in high frequency differential pair applications, such as telecom, or other applications which require enhanced electrical performance."

3. What is your solution to the problem?

"Unique BGA package circuit design layout maximized for differential pair signal traces with Power/Ground planes."

4. When was your solution first conceptually or mentally complete? Date:

5. What is the first tangible evidence of such completion? Date:

6. What is different about your solution, compared with other solutions to the same problem?

"Circuit design layout that achieves low inductance Power and Ground package interconnects as well as controlled signal line impedance that maximizes the number of differential pair signals for a BGA package."

7. What are the advantages of your solution?

- > Maximum number of Signal traces usable as differential pairs:
  - Improved electrical performance.
  - Suitable for high frequency applications, i.e. telecom.
  - Enhanced performance without any additional cost.
  - Flexibility to use nearly all signal traces as differential pairs or single ended lines.
  - Substantially lower cross talk levels.
- > Unique design layout of Signal lines Power/Ground circuitry for enhanced electrical performance:
  - Minimum Power/Ground total inductance
  - Common backside Ground plane for controlled signal line impedance
  - Ability to operate at higher clock frequencies
  - Flexibility to use Power/Ground jumper connections from Power/Ground rings to individual traces for enhancing isolation between signal lines.
  - Substantially lower cross talk levels.
  - Controlled impedance (single end lines, even/odd mode differential pairs).
  - Maximizes number of coupled differential signal pairs in a BGA package.

8. What TI products, processes, projects or operations currently implement your invention?

High performance multi layer cavity BGAs (256 and 352 CD BGA currently in package qualification).

9. What is the date of the first implementation?

10. What record exists to prove this date?

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ASP package road-map and package drawings.

11. Is there any future implementation planned? (Y/N)  
If so, please furnish the TI PART No. or project name

Yes. Currently in use and planned for TI's highest electrical performance ASIC telecom customer applications.

12. Has the invention been published or disclosed to anyone outside of TI? (Y/N) YES When? If planned - when? (Catalog, advertising, data book, application note, conference paper, magazine article, TI TJ, proposal document.) Was there a nondisclosure agreement (NDA)? (Y/N) YES.

13. Has a TI product incorporating the invention been publicly introduced, quoted, sampled or shipped? (Y/N) YES When? Shipped to one European customer since and samples to one Canadian customer in late If planned--when?

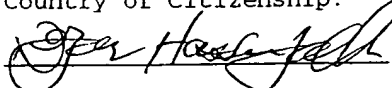
14. Was the invention conceived or first implemented in the performance of a government contract or subcontract? (Y/N) No Contract #: N/A

\*\*\*\*\*  
THE INVENTION DESCRIBED BY THIS DISCLOSURE IS SUBMITTED PURSUANT TO MY EMPLOYMENT, AGREEMENT WITH TEXAS INSTRUMENTS INCORPORATED OR A TI SUBSIDIARY (SPECIFY):  
\*\*\*\*\*

Has this disclosure been previously sent to the Patent Department electronically (unsigned)? (Y/N) No.


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(Signed)  Date            Mail Station 477

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Greg B. Hottel  
Witness 1

1/1  
Date

This invention disclosure with any attachments was read and understood by me on    /    /   .

Michael L. Lauer  
Witness 2

    
Date

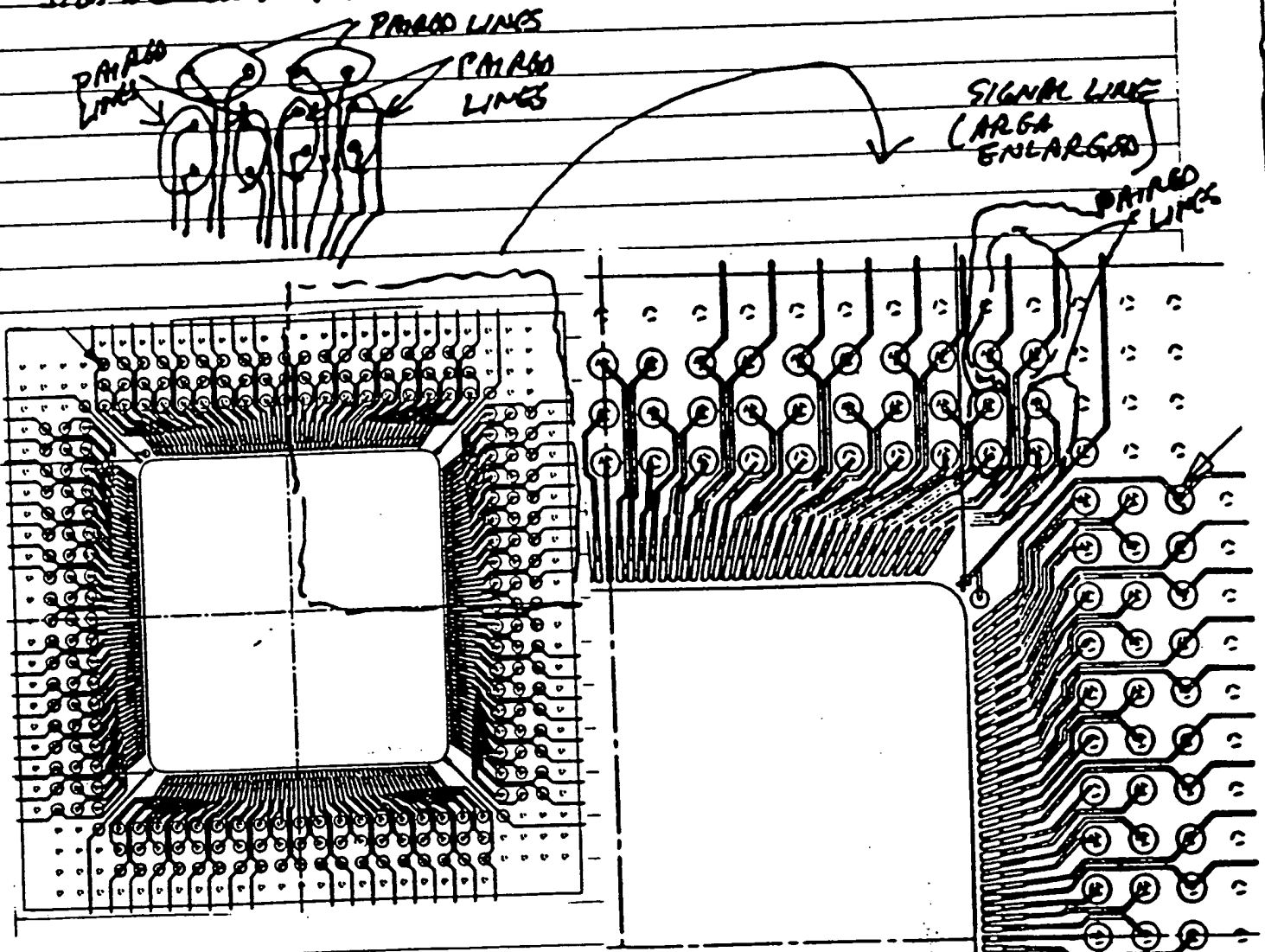
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LAYOUT CONCEPT FOR MAXIMIZING NUMBER OF ADJACENT 'DIFFERENTIALLY PAIR' SIGNAL LINES IN A 'SINGLE' SIGNAL LAYER BGA PACKAGE WITH NOT MORE THAN ONE BALL-PITCH DIFFERENCE IN LENGTH BETWEEN ADJACENT PAIRED SIGNALS.

E.G. 352 BALL BGA PACKAGE WITH 228 SIGNAL LINES (57/QUADRANT) CONSISTING OF 28 DIFFERENTIALLY MATCHED PAIRS = 56 SIGNAL LINES + 1 EXTRA SINGLE-GRADE SIGNAL LINE PER QUADRANT.



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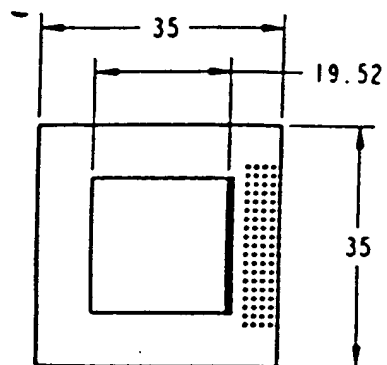
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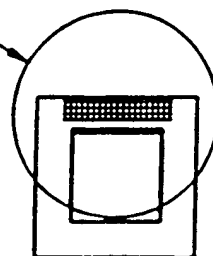
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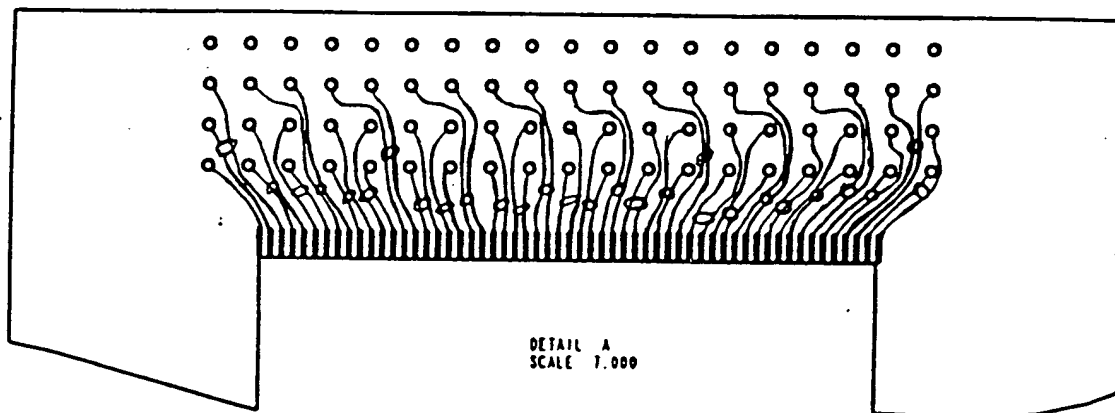


SCALE 1.500

SEE DETAIL A



SCALE 1.000

DETAIL A  
SCALE 1.000SIGNAL LAYER  
352 CAVITY DOWN BGA

(ORIGINAL CONCEPT IN MORE DETAIL)  
(HAND SKETCH PROVIDED BY TI TO SUPPLIER FOR PCB DWG.)

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